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October 20,1995**

Reporting Period: 01 April 1994 - 30 June 1994

Optoelectronic Technology Consortium

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**(PRECOMPETATIVE CONSORTIUM FOR OPTOELECTRONIC
INTERCONNECT TECHNOLOGY)**

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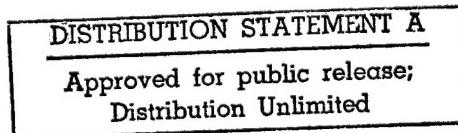
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OPTOELECTRONIC TECHNOLOGY CONSORTIUM
Quarterly Technical Report No. 8
April 1 to June 30, 1994
Honeywell, Inc.

1.0 Introduction

The Optoelectronic Technology Consortium has been established to position U.S. industry as the world leader in optical interconnect technology by developing, fabricating, integrating and demonstrating the producibility of optoelectronic components for high-density/high-data-rate processors and accelerating the insertion of this technology into military and commercial applications. This objective will be accomplished by a program focused in three areas.

Demonstrated performance: OETC will demonstrate an aggregate data transfer rate of 16 Gb/s between single transmitter and receiver packages.

Accelerated development: By collaborating during the precompetitive technology development stage, OETC will advance the development of optical components and produce links for a multiboard processor testbed demonstration.

Producibility: OETC's technology will achieve this performance by using components that are affordable, and reliable, with a line BER<10⁻¹⁵ and MTTF>10⁶ hours.

Under the OETC program Honeywell will develop packaged AlGaAs arrays of waveguide modulators and polymer based, high density, parallel optical backplane technology compatible with low-cost manufacturability. The scope of the program has been modified, such that the number of packaged waveguide modulator arrays to be fabricated under the program will be reduced, and efforts are initiated in the development of Vertical Cavity Surface Emitting Lasers.

The packaged AlGaAs modulator arrays will consist of a single fiber input, a 1x4 fanout circuit, four waveguide modulators, and four fiber outputs, all mounted on a ceramic header. The primary benefits to this approach are enhanced system reliability, particularly at high temperatures, and a device design that is highly producible due to the inherent process tolerance. Combined with the demonstrated high density of these devices when fabricated in arrays, this allows the development of compact and reliable transmitter components.

The objective of the polyimide backplane development effort is to demonstrate a practical high density (>20 lines or channels per mm) parallel optical backplane facilitating (bandwidth x length/power) interconnect figures of merit between one and two orders of magnitude greater than would be attainable with state-of-the-art electrical interconnects. The effort will address both development of an ultimately manufacturable and environmentally tolerant optical backplane, and the optical interface concepts required for practical board-to-backplane optical connection. The key functionalities, and compatibility with standard multiboard assembly practices will be demonstrated in a laboratory evaluation system.

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Technical progress achieved during the current reporting period, and plans for the next reporting period, are summarized in the following sections.

2.0 Progress Summary

2.1 AlGaAs Modulator Array Development. Task leader: Dr. Mary Hibbs-Brenner

No activity during the current reporting period.

2.2 AlGaAs Modulator Array Packaging. Task leader: Mr. John Lehman

During this reporting period operational waveguide modulator arrays were packaged with a single mode polarization-maintaining fiber input, four multi-mode fiber outputs, a GaAs driver circuit provided by Martin Marietta, and a bias tee network designed by Martin Marietta, but fabricated at Honeywell. DC testing was carried out, with the stability of the coupling efficiencies at the fiber-modulator interfaces evaluated over temperature. It was originally planned that high speed test boards would be provided by Martin Marietta, but due to cost growth problems at Martin Marietta, that task was cut. Therefore high speed testing could not be performed on the packaged modulator based transmitters.

Table 1 contains a summary of the loss budget of packaged modulators. The power input to the polarization maintaining fiber from the pigtailed laser is 31mW. The power output from the multi-mode fibers coupled to the output of the modulator array channels ranged from 36 to 70W. This corresponds to a total insertion loss ranging from 29.4 to 26.5dB, of which 6dB corresponds to the intrinsic splitting loss associated with distributing a single input channel among four output channels. This leads to the conclusion that there is 20 to 23dB of excess loss. The contributions to this loss include optical absorption in the waveguide, additional absorption loss due to the metal electrode deposited on the waveguide, excess splitting loss due to imperfect splitters, coupling loss between the single mode fiber and the waveguide array, and coupling loss between the waveguide outputs and the multi-mode fiber.

Table 1. Loss Budget Packaged Modulator 212C L2-3

Loss Budget Packaged Modulator 212C L2-3

Output from pigtailed laser	31mW	14.9 dBm
Output power from pigtailed modulator		
channel 1	0.06 mW	-12.2 dBm
channel 2	0.07 mW	-11.6 dBm
channel 3	0.062 mW	-12.1 dBm
channel 4	0.036 mW	-14.4 dBm
Subassembly loss	min	26.5 dB
	max	29.4 dB

Figure 1 displays the I-V characteristics of the packaged modulator under reverse bias. The leakage current is on the order of 40A at -8V, which is an acceptable level. The optical throughput of the modulator versus applied voltage is displayed in Figure 2. The maximum output is at 0V, while the minimum occurs around 7.5V. A 3dB extinction ratio is observed. This is smaller than what was observed from the same modulator

unpackaged. We attribute the degradation of the extinction ratio to stress induced by the packaging. We had previously seen degradation in contrast ratio due to stress arising from a dielectric coating. However, the voltage length product, 22.5 V-mm, is well within the range of values we have previously observed and which one would expect.

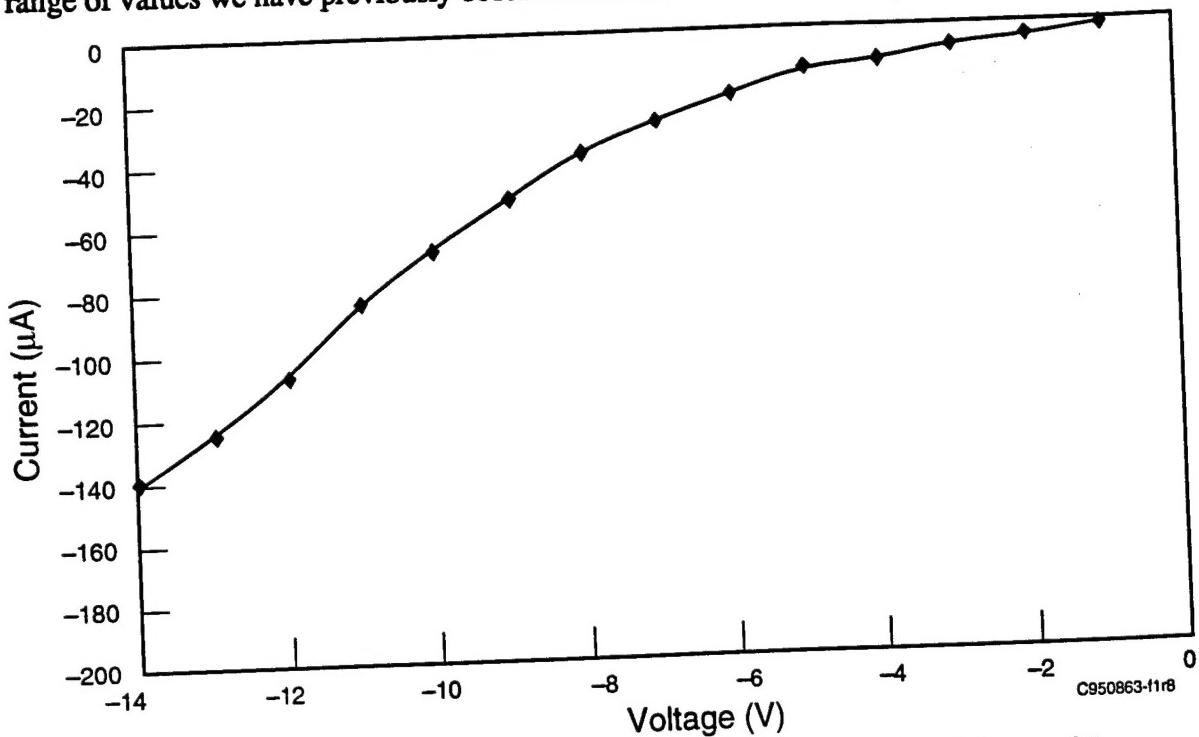


Figure 1: Reverse Bias Characteristics of Mach-Zehnder Waveguide Modulator

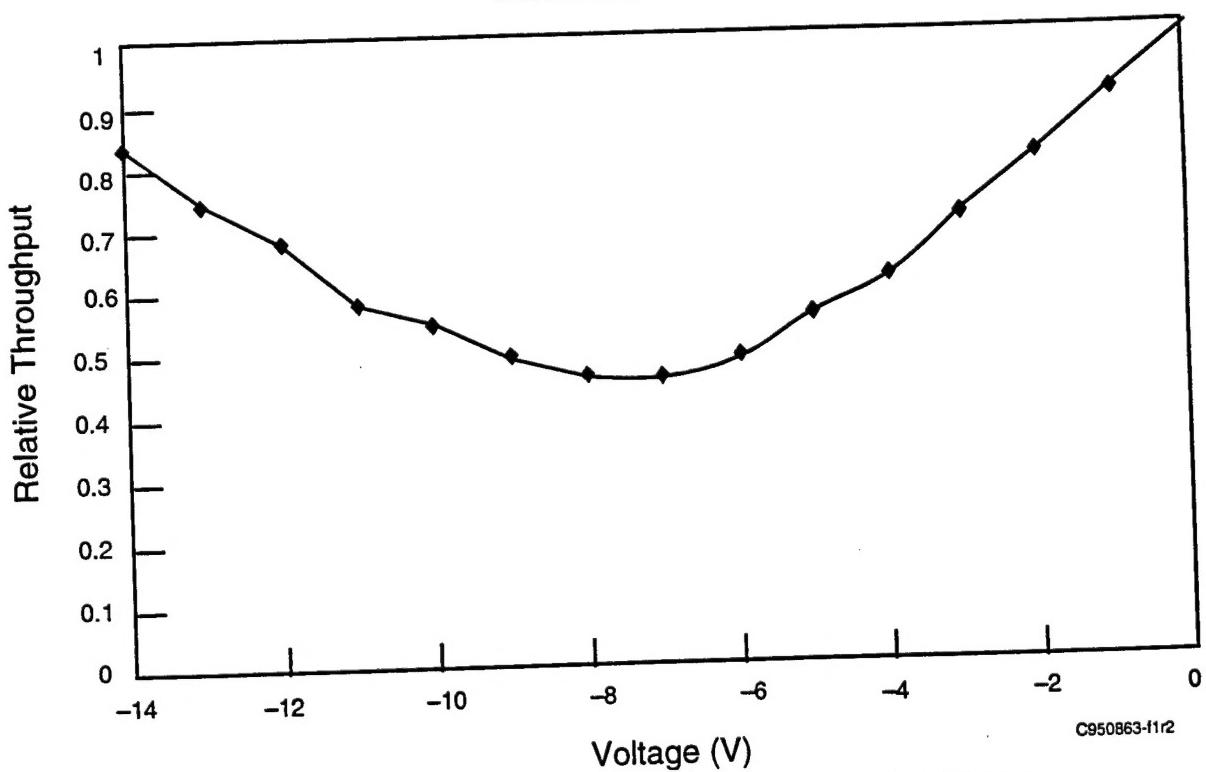


Figure 2: Modulator Optical Throughput Vs. Applied Voltage

Figure 3 illustrates the degree of robustness versus temperature achieved in the packaged system. The relative throughput change was measured over -15 to +70°C and normalized to the throughput at room temperature (20°C). The throughput was found to increase by about 0.5dB at -15°C, and decrease by about -2.3dB at 70°C. The degradation in throughput is due to shifts in the relative positions of input and output fibers with respect to the modulator array, plus any degradation in throughput observed on the chip itself, but is probably dominated by the coupling between the single mode fiber input and the array.

Pigtail Modulator

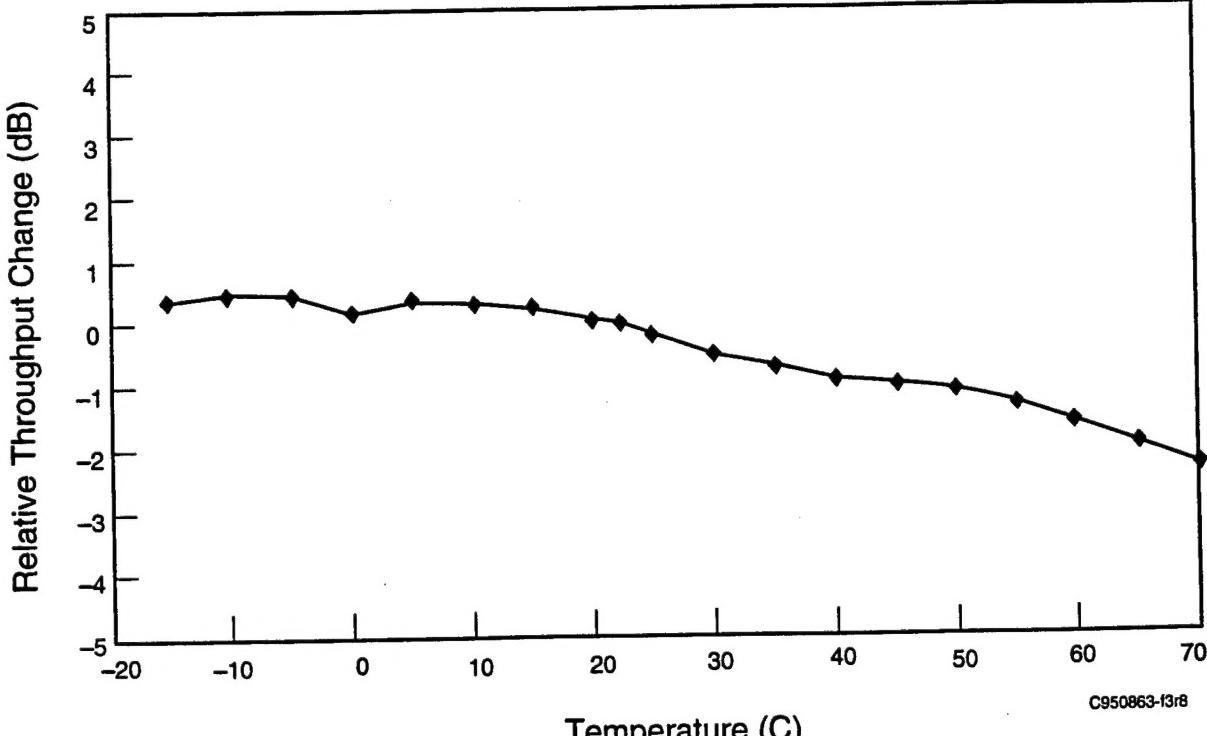


Figure 3: Optical Throughput Vs. Temperature for a Waveguide Modulator Array Packaged with Single Mode Fiber Input and Multi-Mode Fiber Output

2.3. Polymer Backplane Development. Task leader: Dr. Julian Bristow

No activity during the current reporting period.

2.4 Vertical Cavity Surface Emitting Laser Development. Task leader: Dr. Mary Hibbs-Brenner

No activity during the current reporting period.

3.0. Fourth quarter plans

3.1. AlGaAs Modulator Array Development.

The modulator array development task is essentially complete.

3.2. AlGaAs Modulator Array Packaging.

The modulator array packaging task is essentially complete.

3.3. Polymer Backplane Development.

A laboratory benchtop demonstration of a board to board polymer waveguide based interconnect will be carried out. Boards will be mounted on micropositioner stages so that measurements of the connector's tolerance to alignment can be made.

3.4. Vertical Cavity Surface Emitting Laser Development.

This effort will be continued under the OETC-2 program. No further development will take place under the current program.

4.0. Summary

During the current reporting period effort was concentrated on the packaging of the modulator-based transmitter module. Excess optical loss in the fully packaged structure was measured to be 20-23dB. DC electrical and optical characteristics were measured at room temperature. A 3dB extinction ratio was achieved. The voltage-length product and leakage current measured were found to lie within the expected range. The stability of the maximum throughput as a function of temperature was also measured and a maximum degradation of throughput of -2.3dB was observed.

During the remainder of the program we will evaluate the board level interconnect demonstration. In particular we will examine the connector tolerance to misalignment.